DVR BASED INTERFACE FOR MICROGRIDS TO ENHANCE POWERQUALITY

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Abstract:
This paper deals with the interconnection between the microgrid and main network. The Dynamic Voltage Restorer (DVR) is interfaced between the main network and microgrid in order to improve reliability and limit fault currents. The performance of DVR is demonstrated during fault conditions in two different locations, firstly in the main grid and then within the microgrid. The DVR injected a voltage during a fault in the main grid isolating the microgrid from the fault and performs normal operation. Secondly, a novel technique is proposed, magnetizing inductance of the DVR series transformer in order to reduce the contribution of the grid currents during a fault within the microgrid. The proposed technique is evaluated using MATLAB/SIMULINK.

INTRODUCTION:

Power quality is playing a major role in power system in which it consists of electrical, electronic and power electronic devices used in commercial and industrial purpose. Power quality occurs due to harmonics, sag, swell and increase/decrease of loads. It became more important in devices which are sensitive to the quality of power may cause damage to the equipment.

Here voltage sag is considered, custom power devices are used to solve the problem. Among them Dynamic Voltage Restorer (DVR) is most efficient device used in distribution side because of its low cost, small in size and dynamic response is fast. From large power systems, the electric power is delivered from distribution system for each consumer. The end of the power system is distribution system which is directly connected to customers where the power quality depends on distribution system.

Microgrid connected to national grid and operated independently. It is a network designed to provide power for small communities. It connected to both generating units and utility grid preventing from power cuts. Microgrid can operate independently from main grid if required. Microgrids consist of renewable sources such as solar and wind etc.., this increases the reliability of the power system when there is a failure in main grid. By using microgrids the usage of renewable resources increases, emission of carbon dioxide is reduced, large lands usage are avoided.

Fossil fuels such as Coal, Oil, and Gas are reducing because to increase generation to satisfy the demand. According to Global Carbon dioxide emission, Carbon-dioxide (Co_2) was increased up to 6.81% per year because of using of fossil fuels for generation of electric power. By these harmful gases will cause damage to Ozone layer and pollutes the environment directly.

DVR INTERCONNECTION:

A number of papers have been issued introducing different kinds of bi directional fault current limiters (FCL) which will lower the short circuit current level in the microgrid as well as in the main grid during faults in one of two sections.

Use of superconducting materials that have current dependent characteristics as fault current limiters is a spreading analysis field.

Others have suggested hybrid results utilizing solid state devices and semiconductor switches to obtain the same. One of the drawbacks of such solutions is that the amount of regulation over the system is finite. Any extension of the microgrid system itself leads to shift in fault current characteristics based on which the fault current limiter is arranged.

Explanation different from bidirectional fault current limiters have been suggested in where a unidirectional FCL is used to limit the raised short circuit levels when a fault occurs in the main grid whereas the microgrid is near connected to the main grid in line to use it for voltage guide avoiding the current input at the time of a fault in the microgrid.

In a back to back converter is expected as connection between the microgrid and the main grid which provides frequency desolation between the grids and a control of the amount of reactive and active power flow in this one direction.

The purpose of FACTS devices like STATCOMs, SVCs and TCR has changed the Power production. The operation of the Dynamic Voltage restorer (DVR) has been considered broadly in reducing interruptions in voltages on the power system such as voltage sags, swells, unbalance and harmonics in the supply voltage.

Interconnection with DVR:

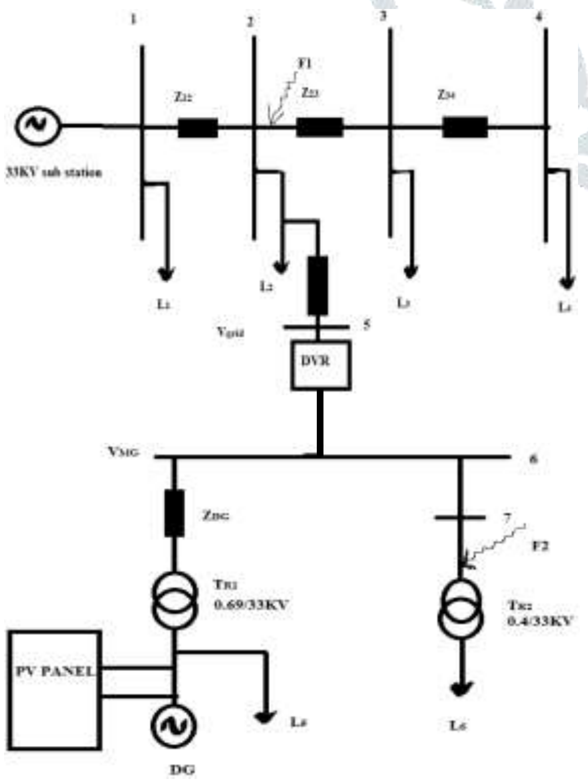

Fig 1: Interconnection with main grid and microgrid with DVR

Near bus 2, microgrid connection is made which contains one distributed generator and two separate loads. Three situations should occur in this interconnection. They are:

Fault in main grid near bus 2

Microgrid voltage reduced to zero. Here microgrid will be isolate from the main grid fault and operates continuously without any disturbance.

Fault in microgrid near bus 7

Microgrid fault current is too limited by the minimum contribution of the main grid to the fault.

Again applying fault in main grid near bus 2

By applying fault again with compensation i.e. DVR will compensate the voltage near bus 2. Hence it maintains normal voltage and reliability of a microgrid increases. Injection voltage of a DVR is in phase with the voltage of a grid.

L_1 to L_4, L_5 and L_6	6MVA, 8MVA and 2MVA
Z_{MG} and Z_{DG}	0.5+j0.3142 ohms and 0.5+j0.0565 ohms
Z_{12} and(Z_{23} and Z_{34})	0.002+j0.6283 ohms and 2+j4.14 ohms

Table 1: Components values

Two modes of operation:

1. Fault in main grid:

Here the microgrid is isolated from the fault. Here the injected voltage is in phase with pre sag grid voltage.

$V_{grid} = 0$.

V_{grid} and V_{mgd} are converted into dq synchronous frame and θ (theta) is obtained from phase locked loop applied to the grid.

$$V_{dq} = \sqrt{\tfrac{2}{3}} \begin{bmatrix} cos\theta & \cos(\theta - \frac{2\pi}{3}) & \cos(\theta + \frac{2\pi}{3}) \\ -sin\theta & -\sin(\theta - \frac{2\pi}{3}) & -\sin(\theta + \frac{2\pi}{3}) \end{bmatrix} \begin{matrix} Va \\ Vb \\ Vc \end{matrix}$$

Voltage is injected in phase therefore q values are not controllable. System is balanced and harmonics are free.

If the system is unbalanced then the positive sequence voltage is utilized for obtaining theta.

The error is passed through PI controller and converts into three phase system to obtain the voltage signals for DVR. Here SPWM technique is used for voltage source converter to inject required voltage.

2. Fault in the microgrid:

Whenever the fault occurs in microgrid , DVR control is to reduces the fault current levels contribution to main grid. By this short circuit rating of all devices cost reduces including transformers in the microgrid. In DVR the use of series transformer reduce the level of voltage of DC link to provide isolation. To reduce the fault current the technique used is magnetizing inductance of a transformer.

Simulation results:

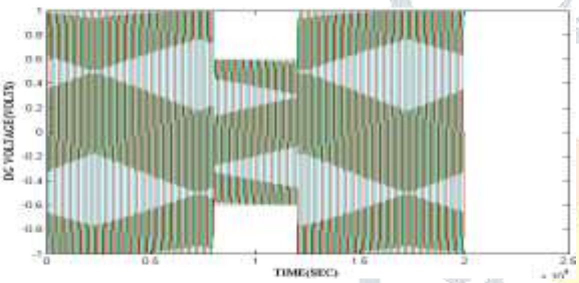

Fig 2: Distributed generation voltage without DVR

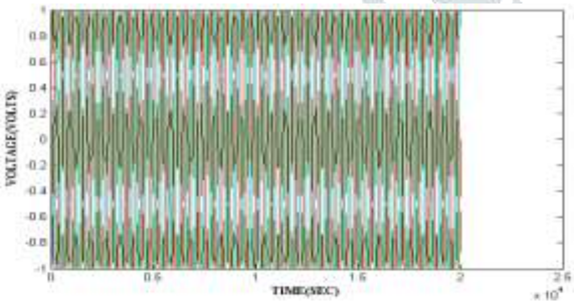

Fig 3: Distributed generator voltage with DVR

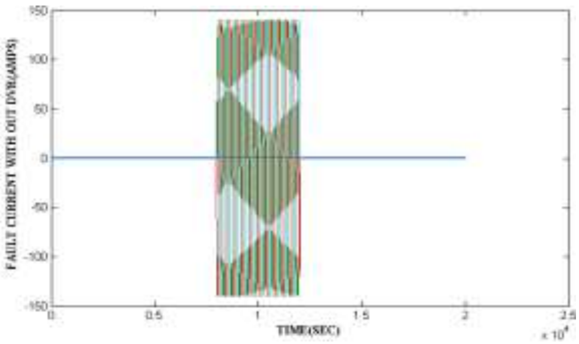

Fig 4: Fault currents without DVR

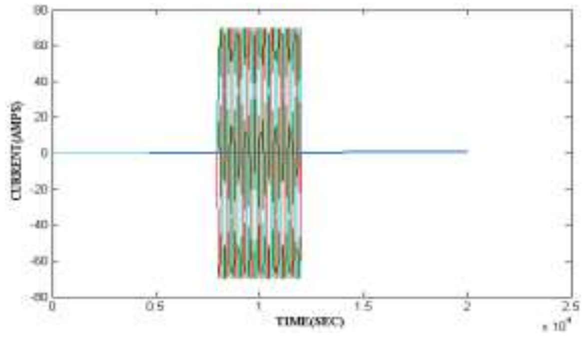

Fig 5: Fault currents with DVR

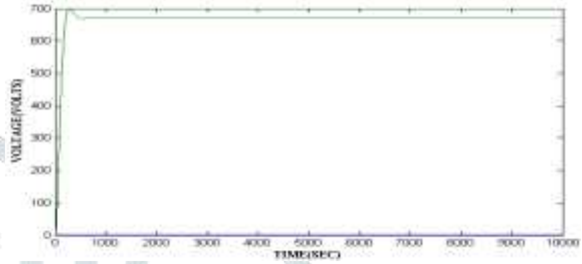

Fig 6: Voltage of a PV panel with and without DVR

Conclusion:

The Dynamic Voltage Restorer (DVR) is interfaced between a microgrid and the main grid. To enhance power quality and reliability the concept of microgrid is considered. Two conditions, fault at main grid and fault at microgrid are considered here. Here, the microgrid is a mixture of renewable sources. Here PV system is considered due to its advantages like reduce the emission of carbon dioxide and acts battery whenever there is a fault in grid. Distributed generator is a renewable source which is not available all times. If the distributed generator is permanent then the DVR usage is reduced.

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